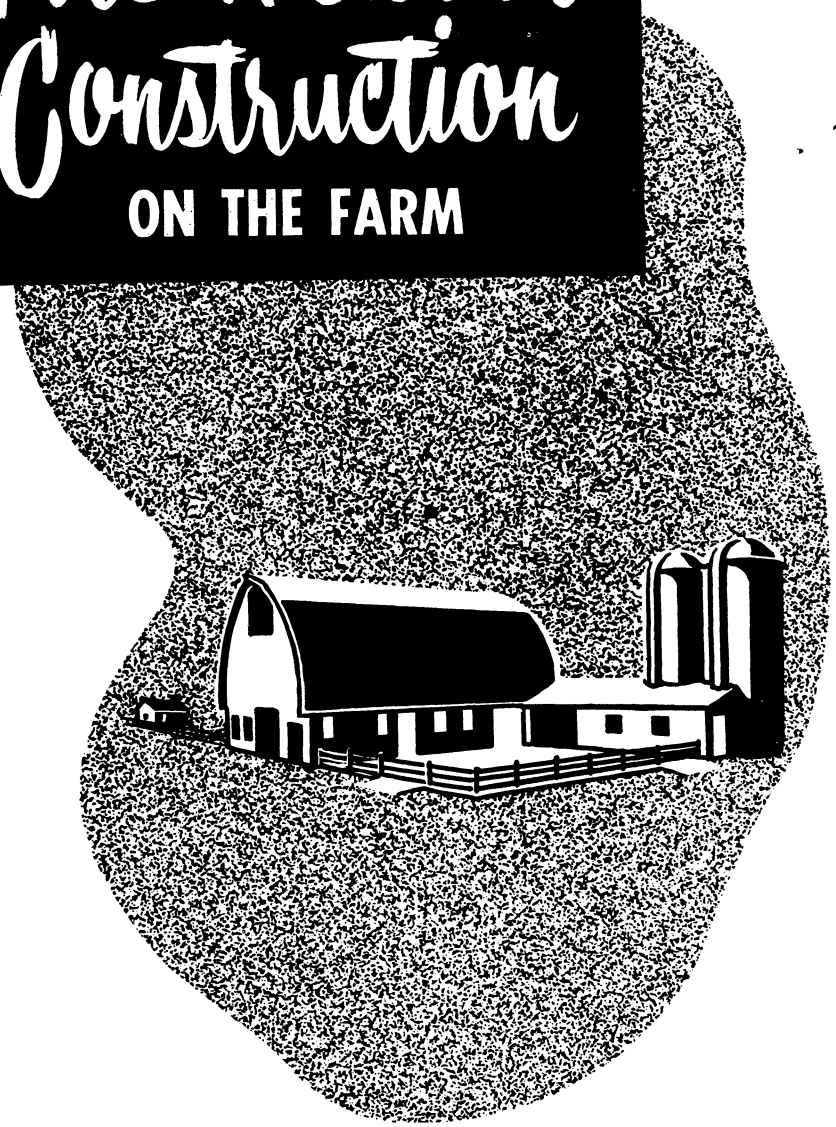
Fire-Resistant Construction ON THE FARM



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CONTENTS

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Fire-Resistant Construction on the Farm

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Every year many people lose their lives in farm-building fires. In addition, livestock, crops, machinery, buildings, and other property are destroyed.

Much of this tragedy and material loss could be prevented if farmers would properly construct and locate farm buildings. Fire-resistant construction reduces the chances of an outbreak of fire, and slows the spread of fires that do get started. The proper spacing of farm buildings retards the spread of fire from one building to another.

Location of Buildings

It is not practical to separate all farm buildings by distances that would completely insure against the spread of fire from one building to another. Such an arrangement would be very inconvenient for doing work. However, it is possible to select a site for a new building or to lay out a new farmstead so that labor can be used efficiently and so that reasonable protection against spread of fire will also be provided.

Heat radiated by a large fire, such as a burning barn filled with hay, would almost certainly ignite any frame building within 50 feet and might ignite any frame building within 100 feet. A space of 150 feet between major structures is needed to give adequate security from ignition by radiation. Poultry brooder houses, heated hog houses, farm shops where welding is done, and buildings used for heated-air drying of grain or hay should be kept 150 to 200 feet from the house and barn if possible.

If buildings are spaced at these distances and grouped around a hard-surfaced court, there is little danger of fire spreading between buildings and it is easy to reach all the buildings with trucks, tractors, trailers, manure spreaders, and other equipment. Such an arrangement also makes it relatively easy for fire-fighting equipment to reach all the buildings.

Spacing buildings 150 feet apart does not cause excessive work and time for doing chores if feed supplies for a few days or a few weeks are stored at each location where livestock and poultry are fed.

The buildings in the farmstead illustrated in figure 1 are spaced far enough apart so there is little danger of fire spreading from building to building. This arrangement is for farmsteads in relatively flat country; the layout would have to be adjusted for farmsteads in hilly areas. Figure 2

[1] Retired.

[2] Acknowledgment is given to the Rural Fire Protection Committee of the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass., for valuable suggestions in the preparation of this bulletin.

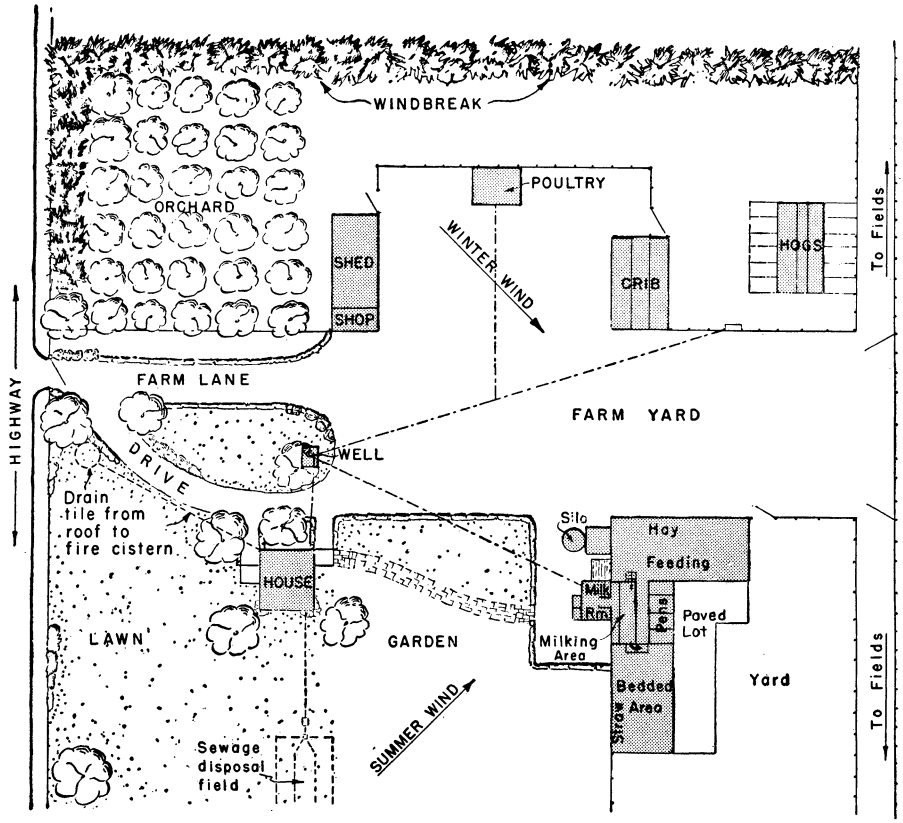

FIGURE 1.—The buildings in this farmstead are spaced to protect them against the spread of fire, but they are reasonably convenient. Note that prevailing winds blow from the house toward the service buildings in the summer.

shows buildings located dangerously close together.

In some parts of the country it has been the custom to connect the dwelling and barns with other buildings directly or by covered wooden passages as protection from the weather. This arrangement increases the risk of total loss of the major buildings in case of a fire. If connecting passages are necessary, they should be provided with a fire barrier at the center. The barrier should be a masonry partition with a tight, heavy, self-closing door. If the roof is of frame construction, the barrier partition should extend through and at least 18 inches above the roof. In areas of heavy snowfall, covered passages are often considered to be worth while because they make it possible to walk between buildings without struggling through deep snow. However, it is usually best not to connect buildings where paths can be easily cleared with a snowplow mounted on a truck or tractor.

The direction of the prevailing winds should be taken into consideration in arranging buildings for fire protection. If prevailing winds blow in the same direction as an imaginary line connecting main buildings the fire hazard is considerably increased. In many areas the second most common wind direction is directly opposite that of the prevailing wind direction. The buildings should therefore be laid

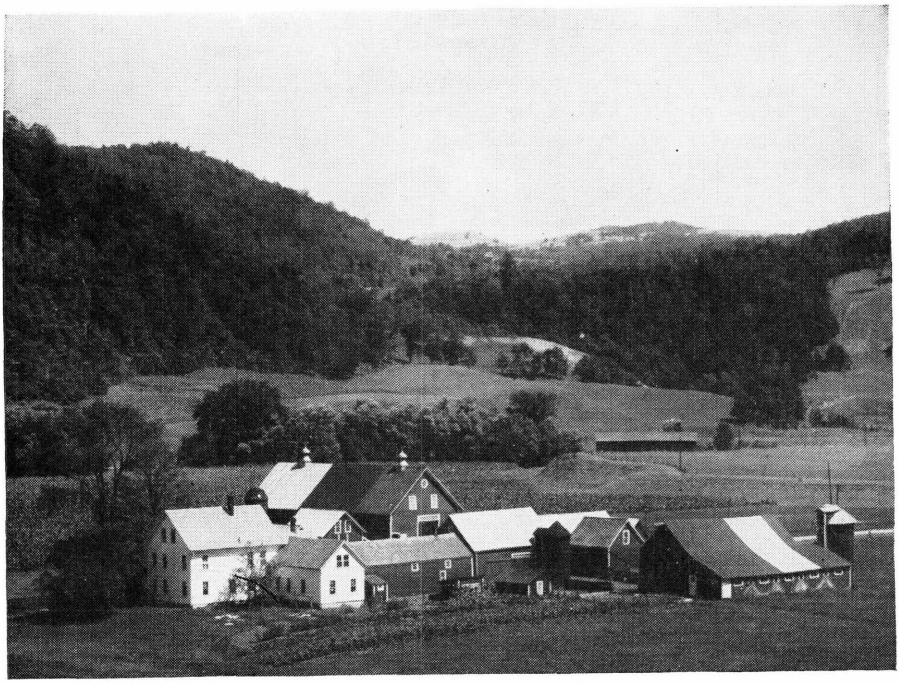

FIGURE 2.—When farm buildings are bunched together there is danger that a fire in one will spread and destroy the entire group.

out so that the line connecting the main buildings is about at right angles to the line of the most common wind directions. A farm layout in which the prevailing winds blow from the barn or the hoghouse toward the dwelling is also objectionable because the dwelling will be needlessly subjected to disagreeable odors. The prevailing wind direction for each section of the United States is indicated in figure 3.

Windbreaks should be located in a position where they will not be in danger of catching fire from a blaze in an adjacent woodlot or growth of brush. There should be enough distance between windbreaks and buildings so that if a windbreak ignites, the fire will not spread to a building.

Water Supply

The farm water supply is valuable for fighting and preventing the spread of small fires, but is seldom adequate if a fire has a good start. To prevent the heat radiated by a big fire from igniting nearby exposed property there must be a large supply of water near the farmstead and there must also be equipment for delivering the water onto the exposed buildings.

Lines carrying electric power for the farm water supply system should not be attached to a building. The power is likely to be cut off if the building catches fire. Power for the water system should come directly from the main switch at the meter, which is preferably located at a pole in the yard.

Rural fire trucks sometimes carry 300 gallons of water for quick use,

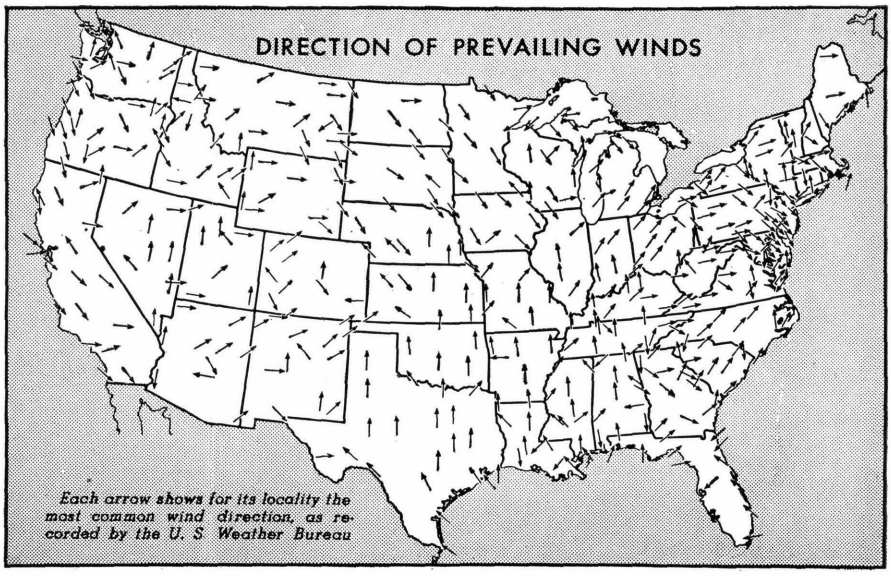

FIGURE 3.—The arrows on this map indicate the most common wind direction for various parts of the United States. There are many local variations in wind direction that can only be determined at the building site.

but their pumps can handle 500 or more gallons of water per minute. Fog or spray nozzles are used by some fire departments. The rate of flow through fog nozzles is much less than the rate of flow through a solid stream nozzle. If the services of a fire company are available it is well to have a pond (fig. 4), or reservoir, at a distance between 150 and 500 feet from the farmstead.

The water supply for fighting fires should be located on a road that is passable in all seasons. Ponds or other surface supplies of water should be fenced in and a sump pit

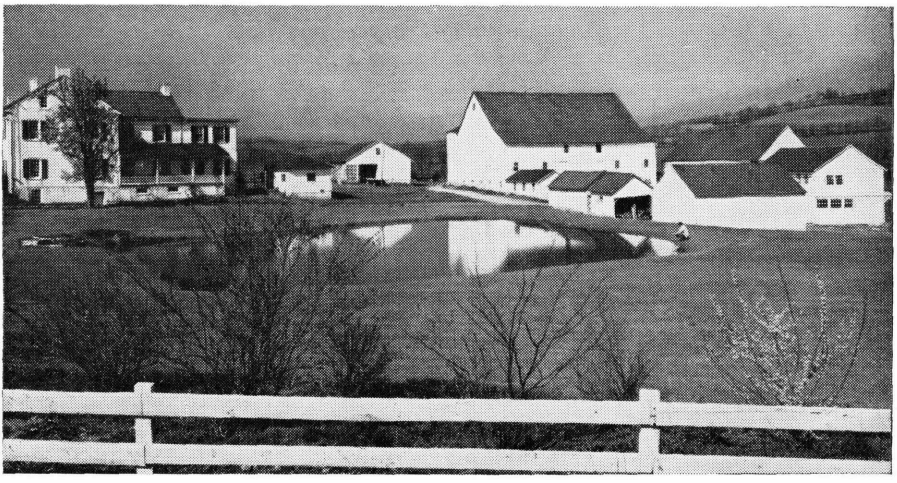

FIGURE 4.—A pond located close to the farmstead is a valuable source of water for fighting fires.

8 to 10 feet deep for the suction hose of the pump should be located next to the road. If the pond cannot be located where it can be reached by a fire truck, it may be possible to pipe the water to a fire hydrant or a covered sump pit from which the truck's pump can draw. A 6-inch pipe is needed to carry water from the pond to the hydrant or sump.

The local volunteer fire department should be consulted about water-storage requirements. As soon as possible after a water supply is made available the fire chief should be provided with a map similar to figure 1, showing the layout of buildings, roads, fences, and accessible water supplies.

A 1-hour supply of water at a flow of 500 gallons per minute requires a pond about 35 feet in diameter with an average depth of 4 feet. Cisterns can be used as water reservoirs, but only exceptionally large cisterns hold enough water to be effective against a big fire. A cistern 8 feet in diameter and 10 feet deep will hold a little over 3,750 gallons of water, which is enough to supply a flow of about 60 gallons per minute for an hour.

Dwelling Construction

Dwellings often are not the most costly buildings on farms, but because they house the family it is very important that they be protected against fire. Proper care and installation of heating equipment, careful storage of flammable materials, and proper installation of electrical wiring and equipment are some of the measures that can be taken in every home to give fire protection.

Construction features which are for the special purpose of fire protection can be provided when the house is built, or can be added to most old houses. These features can be included in all parts of the house, from the cellar to the roof.

Cellars

Cellars should be kept as free as possible of accumulations of papers, rags, and other trash. Special care must be taken to keep such flammable material away from heating equipment; it should not be stored under cellar stairs, adjacent to posts or wood partitions, or close to electric wiring or equipment.

The ceiling in the cellar should be high enough to permit the safe installation of heating equipment (see page 20). Sufficient headroom for the heater may be provided in cellars with low ceilings by placing the heater in a well-drained, shallow pit. Where there is considerable ground water the pit must be waterproofed or provided with a sump pump or other arrangement for safe dewatering. A noncombustible ceiling, such as wire lath and plaster or ½-inch gypsum board and plaster, should always be provided over the heating equipment and smoke pipe.

The construction of the cellar should be such that it will slow the spread of fire. Masonry walls and partitions, masonry piers, and reinforced concrete girders are fire resistant. Steel columns and girders are structurally strong, but they should be protected with a concrete or plaster covering. Unprotected steel columns and girders may buckle in a hot fire and open up floors and partitions, thus permitting rapid spread of fire.

If wood posts are used to support the ceiling they should be solid and at least 6 inches thick in the least dimension. Wood pillars should stand on concrete or masonry footings extending at least 4 inches above the floor. The footings give protection against ground moisture and insects.

A fire-resistant ceiling over the entire cellar is not essential, but helps to prevent the spread of fire. A fire-resistant ceiling may be made of ½-inch gypsum board and plaster, or metal laths and plaster finished tightly against outer walls, sills, and girders. The walls and ceilings of stairways should be finished with the same material. A fire-resistant ceiling may conceal termite damage, however, and may be objectionable in areas where these pests are found.

If a fire-resistant ceiling is not installed, the flooring above the cellar should be double, with asphalt or tar paper between the layers. This type of floor reduces the spread of fire because there are no drafts through it. A double-layer, insulated floor also prevents dust from passing from the cellar to the room above and is a warmer, stronger floor than a single-layer floor. A reinforced concrete or tile floor above the cellar provides very good protection against the spread of fire and makes a ceiling in the cellar unnecessary.

Masonry Walls

Masonry walls are often finished on the inside by placing finishing material over furring strips. Fire-stopping (blocking material) is needed between the masonry and the finish if the spaces between the furring strips connect with the spaces between the joists in floors or ceilings (fig. 5, *A*). Floor joists which extend into masonry walls should be cut diagonally at the ends, as shown in figure 5, *A*. In case the joists burn enough to collapse, the diagonally-cut ends will not pull the walls down. Joists cut square on the ends will act as levers to pull down the walls.

Stairways

Loss of life in farmhouse fires may result if people are trapped on an upper floor and the only stairway is impassable because of fire or smoke. In large houses it may be well worth the extra cost to have two stairways, located so that both are not likely to be impassable at the same time. The cost of the extra stairway may be justified by the added safety it provides against fire and by the added convenience for general use. A window or door opening from an upper-floor room onto a porch or porch roof is a good construction feature which has saved many lives in dwelling fires. Window openings used as fire escapes should not have storm windows or permanently fastened wire screens.

The spaces under the treads between the carriages of all stairways should be fire-stopped with plaster and heavy wooden blocking (fig. 6). If the stairway passes through a partition, fire-stopping should be placed at the partition to prevent the passage of fire from one room to another.

Open stairs cause rapid spread of fire because they act as chimneys for hot, gas-laden air to rush from lower to higher floors. Stairs are especially dangerous in spreading fire if the base of the stairs is in a hall or room having wide, doorless openings into other rooms. Open stairways and wide, doorless openings between the stair hall and other rooms are often desirable to make an attractive arrangement of rooms. For fire protection, however, it is desirable to have openings leading from the stair hall provided with doors. A closed hall also conserves heat in winter.

Cellar stairways should be closed at the top with a tight, heavy door.

Fire-Stopping in Frame Buildings

In farmhouses with "balloon" framing the hollow spaces between the studs in walls and partitions may be continuous from the cellar

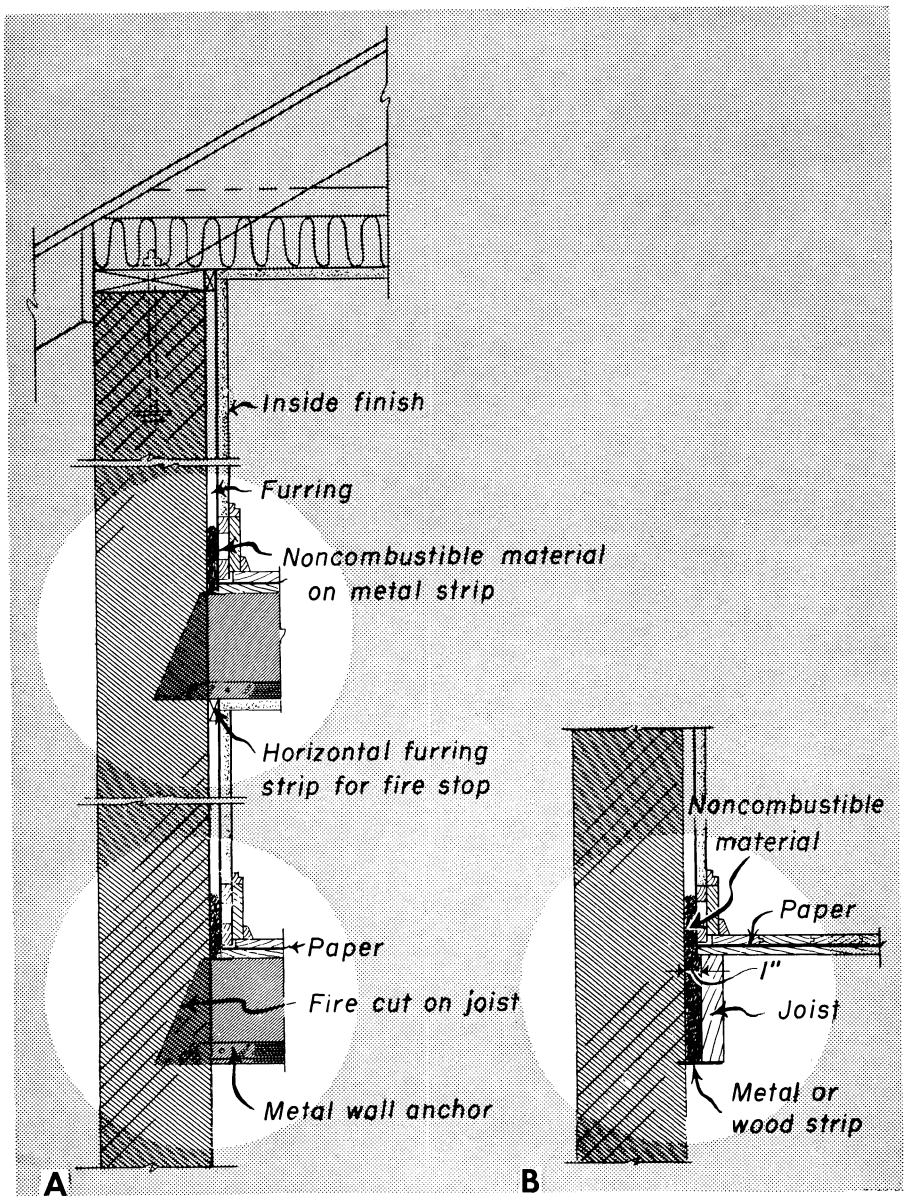

FIGURE 5.—If a building has masonry walls the spread of fire in the flooring and wall finishing can be retarded: *A*, By providing fire-stopping between the masonry and the inside wall, or *B*, by setting the joists which run parallel to masonry walls 1 inch from the wall and packing the space between with noncombustible material.

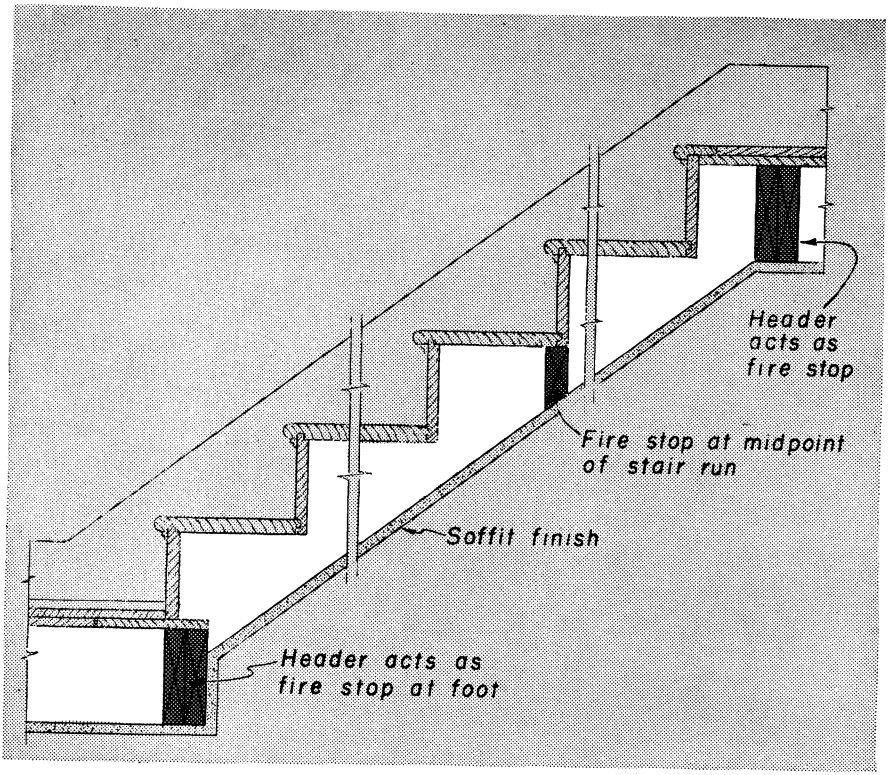

FIGURE 6.—Fire-stopping at top and bottom prevents a stairway from acting as a flue to spread fire. A long stairway should also have a fire-stop midway in the stair run.

to the attic and may also connect with the hollow spaces between joists. These spaces provide draft and act as chimneys which allow hot gases, smoke, and flames to spread rapidly. Gases and smoke carried through the spaces may also overcome sleeping persons.

The spread of gases, smoke, and flames in balloon framing can be prevented with fire-stopping. Figure 7 illustrates the use of wooden blocks for fire-stopping in a house with balloon framing. A noncombustible material supported on metal strips can also be used. The cost of fire-stopping in new buildings is moderate, but it may be costly and impractical to provide complete fire-stopping in old buildings. However, even in old buildings, blocking should be installed at the walls between the first-floor joists.

Noncombustible insulation material is an effective fire-stop if it completely fills the spaces between studs.

Figure 8 illustrates fire-stopping in a frame building with "platform" framing.

Wooden fire-stops should be cut from 2-inch lumber and must fit openings tightly to prevent the passage of air or hot gases. Cracks around stopping may be calked with plaster. The stopping in vertical air spaces may be sealed by covering the top with a 3- or 4-inch layer of a noncombustible material such as mineral wool, broken-up mortar, plaster, concrete, brick, cinders, or a mixture of sand and gravel.

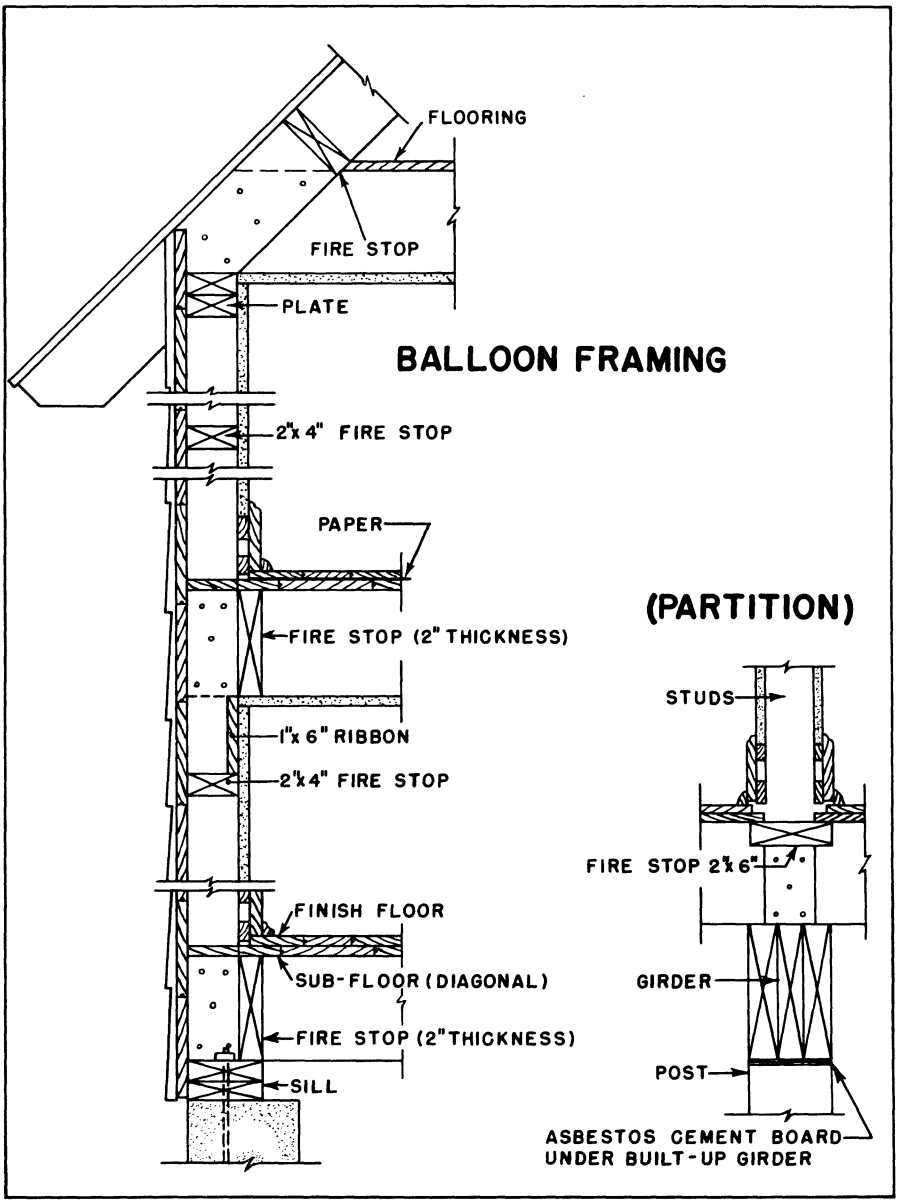

FIGURE 7.—Wooden blocks can be used to provide fire-stopping in houses with balloon framing.

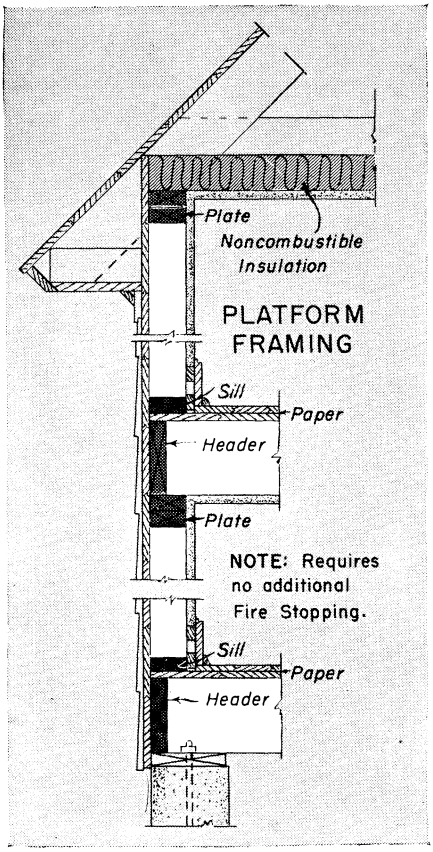

FIGURE 8.—In platform framing the sills and plates close the spaces between studs and act as fire-stopping.

Chimney and Flue Construction

Defects in chimneys, smoke pipes, and chimney connections are among the most frequent causes of fires in dwellings. Masonry chimneys should always rest firmly upon an adequate foundation below frost level and not on wall brackets. The chimney foundation should be of concrete and wide enough to extend at least 6 inches beyond the edge of the chimney on all sides. The foundation should be at least 12 inches thick.

All masonry chimneys should have fire-resistant flue linings for efficient operation and fire safety. Vitrified clay is usually used for lining. The walls of lined chimneys not more than 30 feet high should be at least 4 inches thick if made of brick or reinforced concrete, 8 inches thick if made of hollow building units, and 12 to 16 inches thick if made of stone. All joints should be filled solid with mortar consisting of 1 part port-

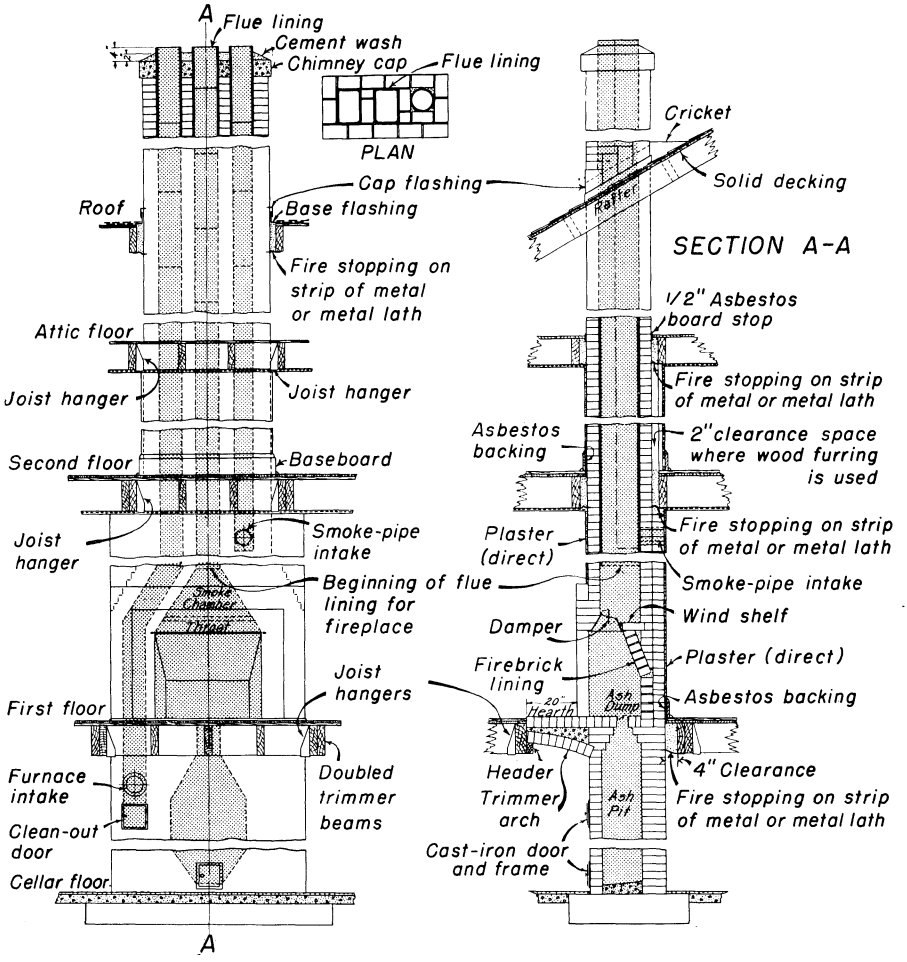

FIGURE 9.—Front view of a properly constructed fireplace and chimney (left); sectional view of the chimney (right), illustrating the use of fire-stopping around the chimney and the use of asbestos between the woodwork of the house and the plaster on the chimney brickwork.

land cement, 1 part hydrated lime, and 6 parts of sand, measured by volume.

No wood framing, furring, lathing, or other burnable material should be built into or be in direct contact with the masonry of any chimney. A clearance of at least 2 inches between the chimney and any combustible material is recommended. The space should be filled with loose, noncombustible material held by strips of metal lath or wire fabric. Figure 9 illustrates a good type of chimney construction and also illustrates the use of fire-stopping around a chimney.

Patented, metal-lined flues can be purchased and used as substitutes for masonry chimneys. Such flues should be stamped with the approval of the Underwriters' Laboratories, Inc., for the type of fuel to be used. A patented chimney is

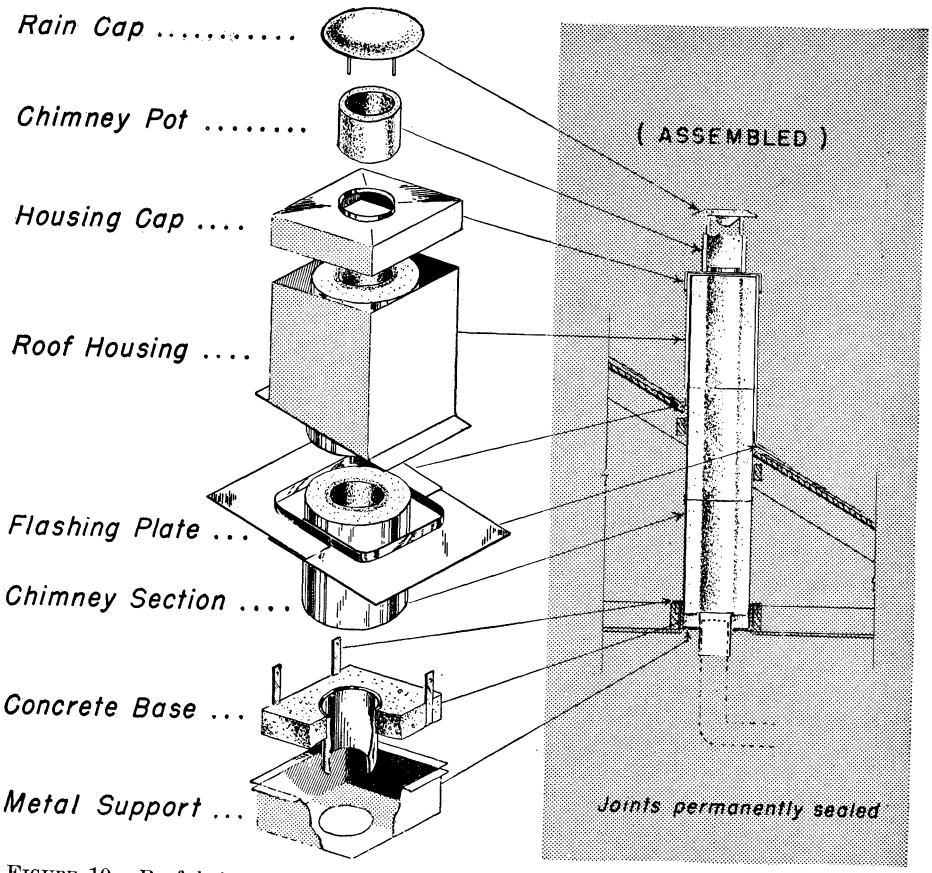

FIGURE 10.—Prefabricated metal-lined chimneys give good protection against fire if installed and used according to the manufacturers' directions.

illustrated in figure 10. Some metal-lined chimneys may be used only in one-story houses.

Smoke Test for Leakage

Every flue should be subjected to a smoke test before the heater is connected. The test may be made as follows: Build a paper, straw, wood, or tar paper fire at the base of the flue, and when the smoke is passing in a dense column out of the chimney tightly block the outlet at the top by laying a board or wet sack over it. If there is a leakage, smoke will appear at the opening. Flues so tested frequently reveal very bad leaks into adjoining flues, directly through chimney walls, or between the flue linings and chimney walls. When the smoke test indicates leakage the defect should be remedied before the chimney is used. Remedying such defects is usually difficult; it is wise to watch chimney construction closely as it progresses.

Some brick masons say that all flues leak. This is not true; every flue can be constructed to be leakproof.

Care and Repair of Masonry Chimneys

It is a good idea to inspect chimneys every fall. Inspection of

the chimney above and below the roof line is particularly important. Chimneys deteriorate most quickly at the top due to the combined action of weather and gases. A smoke test or an electric light let down on a cord are aids in finding defects in the chimney.

Small cracks may be filled with mortar consisting of 1 part of portland cement, 1 part of hydrated lime or slaked lime putty, and 6 parts of clean sand. Mortar made of a good masonry cement and sand may also be used. Premixed chimney mortar is available from many hardware suppliers. The bricks around cracks should be wet before the cracks are filled.

Where mortar has begun to fall out from between the bricks, it should be tested from the outside with an ice pick or other sharp implement to see if there is an opening all the way through the wall. If the pick can be pushed through, the following repairs should be made at once: The chimney should be torn down to a point at least 18 inches below the roof, even if the poor joints do not extend that far down. When all the deteriorated part of the chimney has been torn down, good brick and mortar should be used to build the chimney up around a fire-clay flue lining. The inside measurement of the flue lining should be the same size as the inside measurement of the original chimney. If more extensive repairs are needed it may be necessary to tear down the entire flue portion of the chimney and rebuild it.

Chimney Connections

Proper care in setting and looking after connections between smoke pipes and chimneys greatly reduces the danger of fires due to defective construction.

Smoke pipes should enter the chimney horizontally, and the connection through the chimney wall be made airtight with fire clay or metal thimbles tightly set in the masonry. The space between the thimble and any wood framing should be at least 18 inches and should be covered with metal lath and plaster. A tight-fitting collar for the pipe on the outside of the chimney will also help to make the connection airtight. The smoke pipe should not project into the flue beyond the face of the flue lining. Such projections form a shelf on which soot can accumulate and may cause a poor draft by reducing the flue area. Figure 11 illustrates two types of smoke-pipe connections in chimneys.

When smoke-pipe openings are not in use during the summer they should be closed with tight-fitting metal covers. If the openings are not to be used during the heating season a safe way to close them is to block them up with brick laid in lime mortar, and plaster the surface. If a metal cover is used over an opening during the heating season it should be of an insulated type, as an ordinary metal cover may become hot enough to scorch wallpaper or furniture.

Smoke pipes should not be within 18 inches of any woodwork unless at least the half of the pipe nearest the woodwork is protected by 1 inch or more of fire-resistant covering. A metal casing or asbestos board 2 inches from the upper half of the pipe is sometimes installed to protect woodwork directly above the pipe. When a smoke pipe is protected with this kind of a shield the distance to any woodwork or combustible material should never be less than 9 inches. Wooden boxes, barrels, or other combustible material should not be stored under or near a smoke pipe.

If a smoke pipe from an ordinary range or stove must pass through a wooden partition the woodwork should be properly protected. This

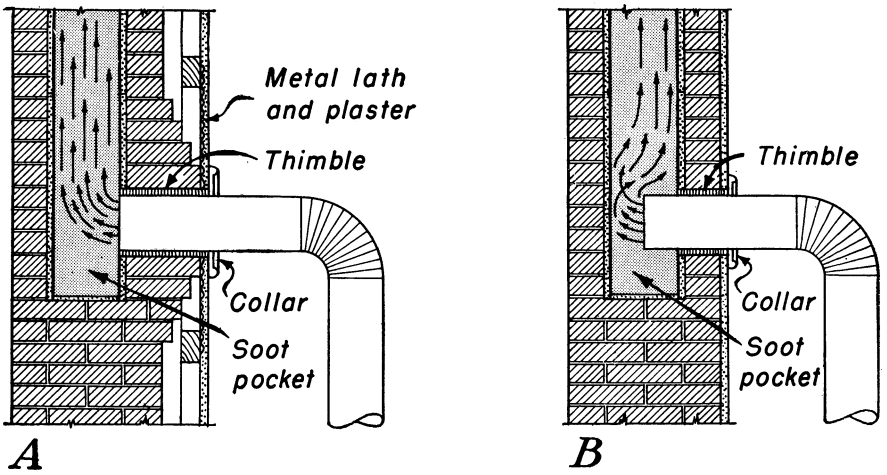

FIGURE 11.—*A*, Smoke-pipe connection through a furred wall. Bricks are built out to the wall to support the thimble. *B*, Connection through a chimney wall without furring. Note that the pipe extends too far into the flue; it should be as shown in *A*.

can be done by cutting an opening in the partition and inserting a galvanized-iron, double-walled ventilating thimble at least 12 inches larger than the outside diameter of the smoke pipe (fig. 12). The woodwork can also be protected by surrounding the pipe with brickwork or other noncombustible material. Pipes should not be jointed in the thimble, and the section of pipe passing through the partition should be secured in place to keep the pipes from being jarred apart or moved closer to any woodwork. Smoke pipes from furnaces or boilers should never pass through wooden partitions.

Smoke pipes should not pass through floors, closets, or concealed spaces and should not enter a chimney in an attic. Smoke pipes should never be sloped downward toward the chimney and should be cleaned at least once a year. Metal smoke pipes should be inspected frequently, especially on the underside.

Detailed information on chimneys, fireplaces, and smoke pipes is

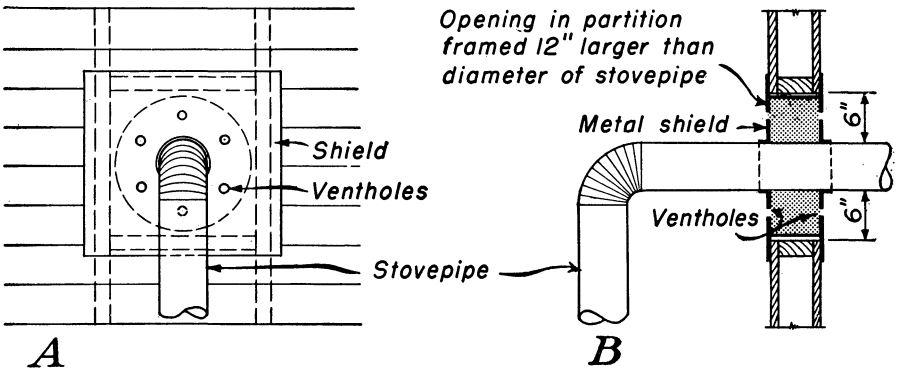

FIGURE 12.—*A*, Front view of a metal, double-walled ventilating thimble in a wood-frame partition; *B*, sectional view of the same protecting device.

given in Farmers' Bulletin 1889, Fireplaces and Chimneys. This bulletin may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. 25 cents.

Radio and Television Aerials

Good reception is not the only factor to be considered when radio and television aerials are installed. Other important factors are the kind of mast or tower, location, protection from lightning, and separation from electric power lines. Antennas should be substantial enough to withstand any likely wind or ice load that might cause them to fall over power wires. The lead-in conductors should be placed at least 6 feet away from any part of a lightning-rod system. All antenna masts and aerial equipment should be equipped with lightning arresters approved by Underwriters' Laboratories and should be effectively grounded. Antennas should be installed in accordance with the requirements of the National Electrical Code.

Do not attach radio or television antennas to chimneys. Wind causes antennas to vibrate. The vibrations will in time weaken the mortar joints and cause cracks and leaks, even if the chimney is well built. Such cracks not only reduce the effectiveness of the chimney but may permit sparks to escape and become real fire hazards.

Roofing

The roof covering is one of the points most vulnerable to fire. The fire resistance of a roof covering is determined by the kind of material used for the covering and the manner in which it is applied and maintained. There are a number of roofing materials available which afford satisfactory protection and service if applied and maintained in accordance with the manufacturers' directions. Tile, slate, asbestos cement shingles, and metal are the most fire-resistant roof coverings.

Asbestos cement, asphalt, and composition roofing materials are given fire-resistant ratings of various classes by the Underwriters' Laboratories. Roof coverings with a Class A rating are effective against severe exposure, those with a Class B rating are effective against moderate fire exposure, and coverings with a Class C rating are effective against light fire exposure. Bundles or packages of roofing material should not be purchased unless they are labeled as to class. The roofs on farm buildings 100 or more feet apart may be considered as being subject to only light fire exposure and a Class C roofing will be satisfactory. However, a better grade of roofing may be expected to give longer and better service, as well as increased fire protection.

A good roofing material for the dwelling is especially important because the heating equipment in the dwelling is frequently the cause of roof fires.

Provide a spark arrester (fig. 13) on the chimney of a house with a wood-shingle roof in order to burn wood or soft coal safely. Clean the spark arrester occasionaly to avoid clogging. Wet down wood shingles in hot, dry weather or any time there is danger of sparks from nearby fires. Replace old shingles before they deteriorate.

Do not permit leaves or other lit-

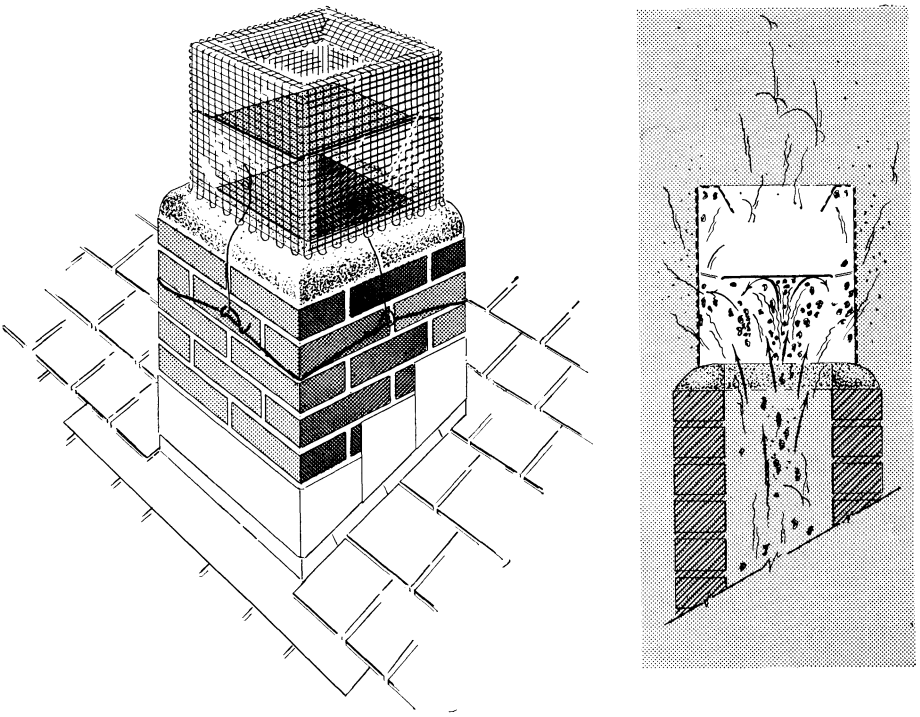

FIGURE 13.—Spark arresters on chimneys prevent sparks from flying out and falling on the roof.

ter to accumulate in the gutters or valleys on a roof—this is especially important on a roof covered with wood shingles.

A good ladder of sufficient length to reach the roof from either side of the building should be kept where it will be accessible at all times.

Electrical Equipment for Dwellings

Electricity is a safe form of energy only when properly used. It becomes a fire hazard when: (1) the wires which conduct it are too small to carry the load; (2) circuits are not properly installed and protected by the right fuses, circuit breakers, or other overload devices; (3) joints or splices are not properly made; (4) too many appliances are connected; (5) heating appliances are too close to combustible materials; and (6) dust and accumulations of other flammable matter are permitted to collect on lamps, motors, and heating devices.

All wiring must be planned on the basis of the expected electric load. The first step in planning is to list all of the equipment that will be used. The second step is to have an experienced electrician or electrical engineer determine the sizes of wires, the number and location of outlets, and the number of circuits required. Distribution panels should have spaces for more circuits than are needed at the time of installation. The extra spaces are for additional circuits when and if they are needed. Heavy or fixed appliances, such as the range, water heater, refrigerator, water-supply pump, and oil burner should each have its own circuit.

Special circuits should be in-

stalled in all buildings where electric motors will be used. It is especially important to have special circuits for all motors of more than ½-horsepower capacity. All wiring in barns and other farm buildings must be so installed as to eliminate the possibility of damage by stock or by having something thrown against it.

Wiring should be done by an experienced electrician in accordance with the National Electrical Code and with any other State or local regulations. After wiring has been installed it should be inspected by a competent and authorized inspector. If the wiring gets damaged in any way, it should be repaired promptly and properly.

Fuses should be used on branch circuits to limit the amount of current flowing through the circuits. Fuses which allow the maximum safe current for the respective wire sizes are as follows:

Gage of wire *Number*	Capacity of fuse *Amperes*
14	15
12	20
10	30
6	50

Number 14 wire is sometimes permitted but it is usually too small for farm use. Branch circuits on which motors are operated should be equipped with "time-lag" fuses or circuit breakers, because when motors are started they often "blow" fuses that are of ample size when the motors are running at rated speeds and operating under full-rated load. The delayed action of a time-lag fuse or circuit breaker allows the motor to start and still gives protection against currents that would overheat the wires.

Appliance cords should be examined frequently for broken insulation and they should never be hung over nails or pipes or laid under carpets. Long appliance cords are to be avoided. It is much better to install adequate wiring with a sufficient number of convenience outlets than to attach a cluster of extension cords to one outlet.

Electric heaters and infrared lamps must be mounted far enough away from combustible material such as wood or straw to avoid ignition of the material. Electric irons must not be allowed to stand on or close to combustible surfaces when the current is on.

Overloaded motors are likely to get hot, especially if the overload continues for any considerable time. When this happens the insulation is often damaged and short circuits result. An accumulation of dust on an electric motor will act as heat insulation and is likely to cause the motor to overheat.

Further information and guidance on the safe installation and use of electricity can usually be obtained from electric-power companies.

Fuel-Burning Equipment

Most urban areas have regulations on the installation of fuel-burning equipment used for heating and cooking, but some rural areas lack such regulations. The following points should be considered when installations are made in areas where there are no regulations: (1) Insulation and metal sheets placed against wood surfaces do not make them fireproof; (2) insulation slows down the movement of heat but does not stop it; (3) repeated heating and cooling of wood makes it drier and easier to ignite; and (4) for practical purposes wood or other combustible material may be considered unsafe if the bare hand cannot be held comfortably against it.

Most furnaces, boilers, and other heating equipment should be set on

concrete foundations. Each type of equipment has special requirements for space, mounting, and venting.

Warm-air ducts should be so arranged that the heated air must travel at least 6 feet from the furnace and make a sharp bend before entering floors or walls. Single-wall ducts covered with asbestos paper at the rate of 12 pounds of paper per 100 square feet of duct must be at least five-sixteenth inch from any wood surface. Installations should be made according to directions supplied by the manufacturer.

All fuel-burning devices must have an adequate air supply for safe operation. Heating plants that are starved for air are likely to give off carbon monoxide and may sometimes explode. If the basement or boiler room is built very tightly, it may be necessary to leave a window open or to provide louvers in the door to admit oxygen to support combustion.

Wood- and Coal-Burning Systems

The clearance which must be provided between wood- and coal-burning systems and ceilings and walls varies with different types of systems. However, a clearance of 48 inches between the front of the unit and the wall is safe for all systems.

Some systems have openings for smoke pipes in the top of the unit. These units must be installed so that the pipe makes a 90° bend and the section of pipe which enters the wall is horizontal. The horizontal section of pipe must be at least 18 inches from the ceiling, and the vertical section which rises from the unit at least 18 inches from the walls. Other clearances for units with a smoke-pipe opening in the top are as follows:

Conventional warm-air furnaces—a clearance of 18 inches on the back and sides.

Domestic ranges without firepot lining—a clearance of 36 inches at the top, back, and sides.

Domestic ranges with firepot lining—clearances of 36 inches at the top, 12 inches at the back, and 24 inches at the sides.

Circulating-type space heaters—a 36-inch clearance at the top, and 12-inch clearances at the back and sides.

Radiating-type heating stoves—clearances of 36 inches at the top, back, and sides.

Stove-type incinerators—36-inch clearances at the top, back, and sides.

Some wood- and coal-burning systems have the smoke-pipe opening in the back. There must be a vertical section of pipe between the unit and the horizontal section of pipe which fits into the chimney opening. There must be at least an 18-inch clearance between the vertical section of pipe and the wall, and there must also be an 18-inch clearance between the horizontal section of pipe and the ceiling. Other clearances for units of this type are as follows:

Mechanical warm-air furnaces with temperature-limit control—a clearance of 6 inches at the top and sides.

Domestic-type hot-water and steam boilers—a clearance of 6 inches at the top and sides.

Water heaters—a clearance of 12 inches at the top and sides.

Hand-fired, forced-air furnaces which burn wood or coal may overheat because of insufficient cold-air return when the fan is stopped by fan-belt breakage, motor failure, or power failure. With no air to carry away the heat, temperatures get dangerously high. Overheating can be controlled with protective devices which provide thermostatic control for opening and closing the ashpit damper. Excessive temperatures cause the devices to close the damper, thus checking combustion.

Coal stokers are also equipped with automatic controls.

Oil- and Gas-Burning Systems

Oil- and gas-fired heating plants are often less of a fire hazard than plants using coal or wood because they are usually equipped with automatic temperature-limit controls.

Any leak in a system using liquefied petroleum (LP gas) fuels may become a serious fire hazard. The vapors from LP gas are heavier than air and tend to settle to the floor or other low areas. They are highly flammable and burn with explosive rapidity. If the use of these fuels is contemplated, provision should be made for possible leakage vapors to flow away. This may be difficult in basements wholly underground. Liquefied petroleum gas containers should be outdoors and away from basement wall openings.

Drainage for liquefied petroleum vapors may be provided by leaving a 2- or 3-inch opening across the top and bottom of the doors to the outside. The floor of the furnace or boiler room must be higher than the surrounding grade, otherwise vapors will remain in the furnace room or basement like water behind a dam. A more positive way to take care of such vapors is to use forced ventilation. The exhaust should take the air from a point within 2 inches of the lowest part of the floor.

Floor, Pipeless, and Wall Furnaces

Floor furnaces hang from the floor joists by flanges attached to the furnace shell. It is necessary to remove a section of at least one floor joist to hang a floor furnace. Substantial headers must be placed across the ends of the sawed-off joists, and the joists that carry the headers should be reinforced to carry the additional weight.

Pipeless furnaces are supported in the same manner as piped furnaces. The shells form the cool-air return of pipeless and floor furnaces. The grille over these furnaces must not be covered by rugs or anything that will obstruct the free circulation of air. The registers of these furnaces get very hot, and for this reason there is an advantage in using wall-type registers. Clothing should not be placed above horizontal registers to dry.

Lightning Protection

Lightning is one of the principal causes of farm fires. A correctly installed and maintained lightning-protection system comes very close to giving farm buildings complete protection against lightning damage. A building without lightning protection is at least 12 times more vulnerable to lightning damage than a building with lightning protection. Although there have been instances where damage has been done to buildings equipped with protection systems, it is probable that the systems were defective.

The type of equipment used in a lightning-protection system and the method of installation are important. It is recommended that all installations be made by experienced persons who will be guided by the manufacturers' instructions.

Lightning-protection systems are not permanently effective without maintenance. They need to be checked periodically for breaks in the wiring and for adequate grounding. The effectiveness of the grounding system depends upon soil conditions and other factors. The grounding system should be checked by proper meters. Further information on the protection of build-

ings against lightning can be found in Farmers' Bulletin 2136, Lightning Protection for the Farm. This bulletin may be obtained from the Office of Information, U.S. Department of Agriculture, Washington 25, D.C.

Service Building Construction

Farmers who plan to construct or remodel barns or other service buildings or make major repairs may reduce the fire risk by properly designing buildings and using fire-resistant materials. Among the practices that reduce fire risk are:

1. The storage of forage crops as silage instead of hay. This eliminates the fire risk from stored hay.
2. The use of a one-story barn, which eliminates the hazard of a burning hay mow above the animals.
3. The use of a loose-housing system for dairy cattle. The loss of buildings by fire in a loose-housing system may be no less than the loss in a stanchion barn, but animals housed in open-front structures are free to leave if the buildings catch fire.
4. The use of open sheds, paved feedlots, and windbreaks for livestock instead of a closed feeding barn.
5. The use of concrete, masonry, sheet metal, asbestos cement, and other fire-resistant materials for buildings. Protection against fire can also be provided by protecting and subdividing wood or metal framing to retard the spread of fire.

Livestock Barns

Danger of fire in barns may be reduced by not allowing smoking (fig. 14) and by taking care in the use of lanterns.

Hay or straw stored in the barn is a fire hazard. Hay that is damp when put in the mow, or not completely cured by a hay-drying system in the mow, is likely to heat and may catch fire. A few hundred pounds of damp hay may ignite spontaneously even though the average moisture of all the hay in the mow is at a safe level. Safeguards against hay ignition are to have all hay cured to less than 20-percent moisture, either by field or mow curing, and to watch it carefully for the first month or 6 weeks of storage to detect signs of heating. Dampness on the surface hay and a fruity smell are signs of a hot spot. Temperatures of the hay may be taken by forcing a pipe down several feet into the hay and lowering a thermometer in the pipe with a string. If the temperature is 150° F. the hay should be moved.

Do not walk on hot hay because there is danger of falling through the surface and into a fire. Lay a plank on the hot hay and walk on the plank. Do not dig into hot hay without having a supply of water handy, as the hay may burst into flame when supplied with air.

It is usually impossible to build the walls and roofs of mows with materials which would completely withstand the heat of a mow fire. However, masonry walls and roofs of fire-resistant materials may prevent the spread of fire to other buildings. It is also important that the roof covering give protection against flying brands from another fire. Roofs and walls should be weathertight because even cured hay may ignite spontaneously if wet by rain or snow.

The construction of frame and masonry barns should provide all possible barriers to the spread of fire. If the mow floor is of 1-inch flooring it should consist of at least two layers. A mow fire must burn for a considerable time before a two-layer floor is damaged enough

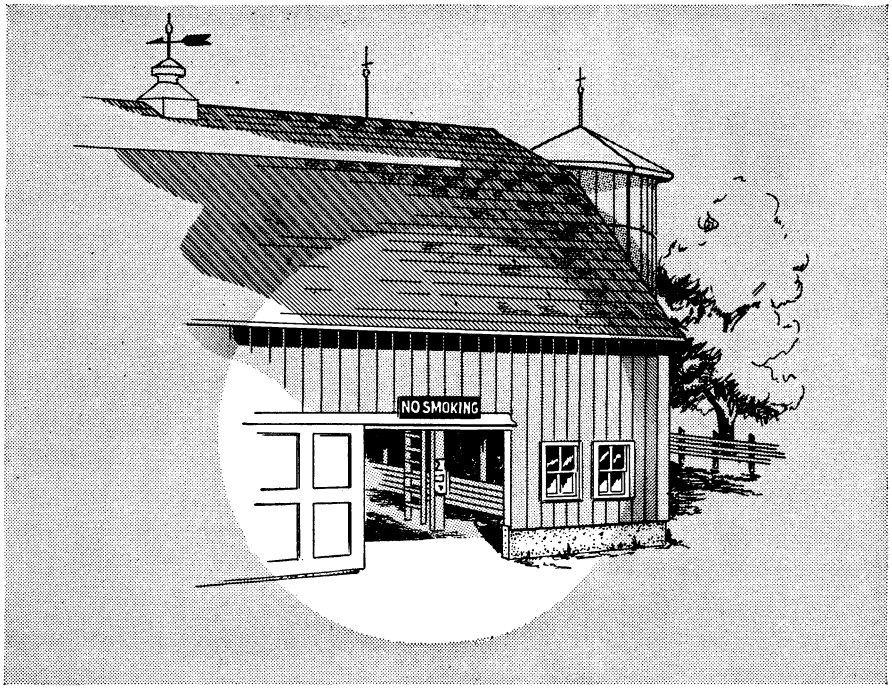

FIGURE 14.—A "No Smoking" sign and a fire extinguisher should be placed in a prominent location in the barn.

to let burning hay drop into the stable. The boards of the top layer should cover the joints of the bottom layer and should be of matched lumber. Additional protection is afforded if asbestos paper or sheets are laid between the layers of flooring.

A reinforced concrete or masonry floor is a more effective fire barrier than a wood floor and in some localities may not cost much more than a well-laid wood floor. A mow floor of masonry should be used only if the side walls are of masonry construction.

It is desirable to line the ceiling of the dairy stable. A lined ceiling is an aid in keeping the barn clean and also gives the livestock added protection from a mow fire. Asbestos cement board ¼ inch thick or ½-inch gypsum board and plaster are good materials for this purpose. Cold drafts over the ceiling can be prevented by tightly stopping the joist spaces at the outside walls. If the joist spaces are not stopped the ceiling should be insulated. If the walls of the stable are lined, fire-stopping should be installed in the stud spaces to prevent the spread of fire through the wall frames. The installation of fire-stopping is discussed in the section, Fire-Stopping in Frame Buildings.

Stairways or ladder hatchways from the lower floor to the mow should be provided with tight, heavy doors (fig. 15) that will stay closed by their own weight or they should be held closed by a wire rope and weight.

All hay chutes should be constructed to prevent the passage of air between the stable and the mow. This can be done by closing the chute opening in the mow floor with a counterbalanced door (fig. 16). If a door is not installed in the floor

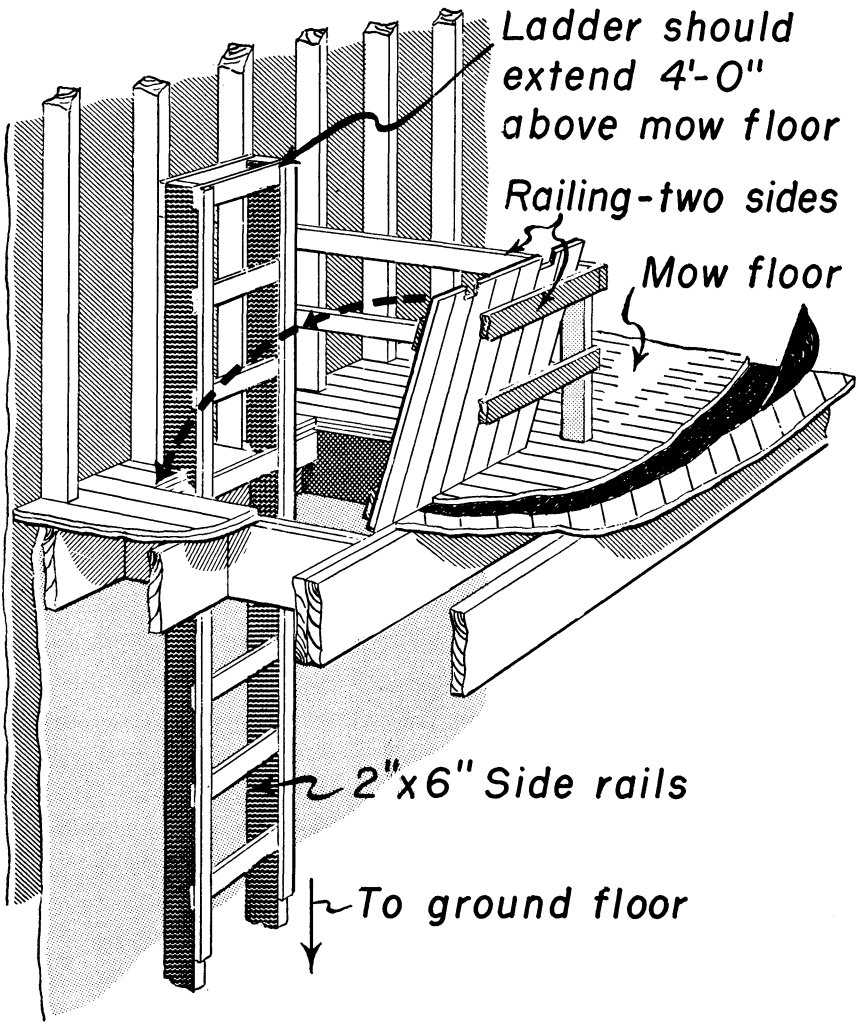

FIGURE 15.—A tight door between the lower floor and the mow provides fire protection by preventing drafts.

opening, a closed chute should extend down to the stable floor and have a tight-fitting door at the bottom. Hay chutes should not be used as ventilating flues for the stable.

In one-story barns a wall of fire-resistant material, preferably masonry, should separate the stable area from the hay-storage area. The wall should be provided regardless of whether hay is stored in the same building that houses livestock or in a separate building. To retard fire most effectively the fire-resistant wall must extend above the roof. Any openings in the wall should be provided with fire-resistant, self-closing doors.

Tobacco Barns [3]

Flues in tobacco barns should be 12 inches or more from combustible

[3] Information on tobacco barns was furnished by the North Carolina Extension Service.

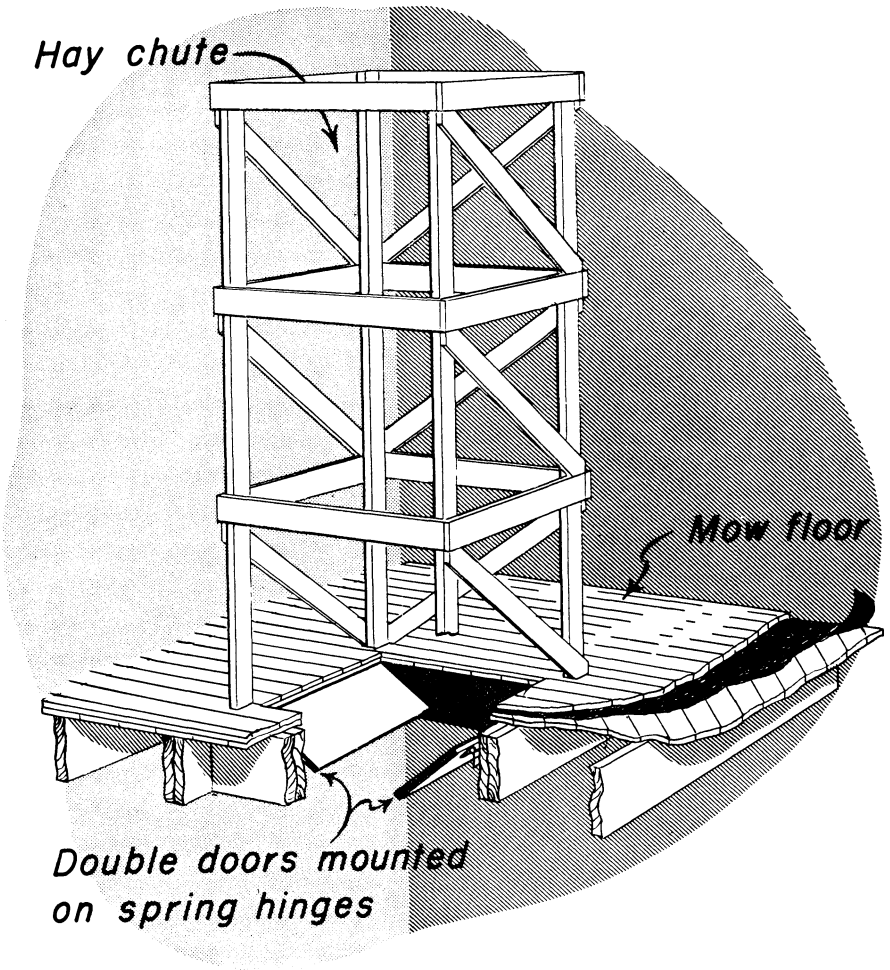

FIGURE 16.—Circulation of air through hay chutes is prevented if a trapdoor is installed at the mow floor.

sills or walls. Heating units should be at least 28 inches from combustible material (fig. 17) and must not be operated at temperatures above those for which the equipment was designed. Fifteen inches or more of masonry must be provided between the furnace and any combustible part of the frame structure.

Locate the bottom tier poles high enough so that the tobacco will hang not closer than 3 feet above the flues or other heating equipment. Suspend poultry netting over the furnaces and flues to catch falling sticks and leaves. Each section of smoke pipe should be securely wired to adjoining sections, or sections may be connected with sheet-metal screws on opposite sides of the pipe.

The stack elbow coming from the barn should be supported on a masonry footing. If a metal stack is used, it should be at least its own diameter from the barn and anchored in four directions with wire or metal bands. A clearance of 12 inches between the stack and flammable material should be allowed if

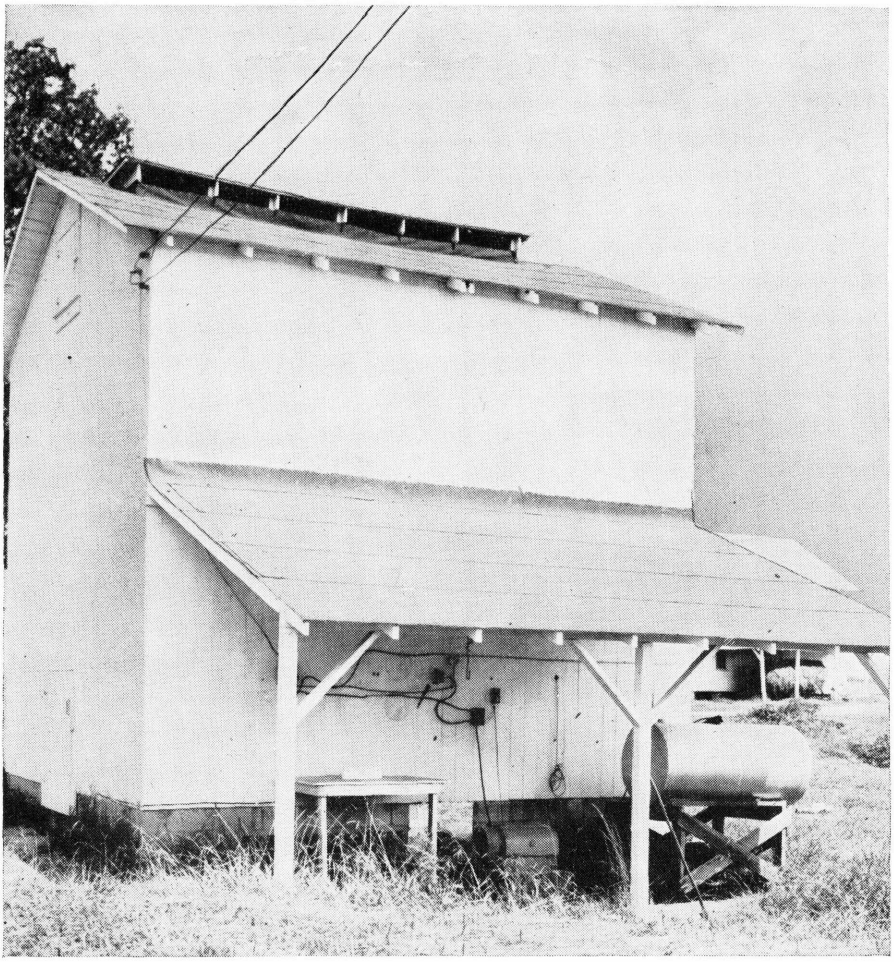

FIGURE 17.—The oil-burning heating unit is outside this tobacco barn and the hot-air duct is separated from the barn by masonry.

the stack passes through a roof or wall. Better draft and less fire hazard may be expected if the stack extends about 2 feet above the ridge of the barn roof.

Poultry Houses

Laying-house and brooder-house floors are usually covered with shavings, straw, or chaff. Matches or cigarettes dropped into the litter may cause it to smolder or burn, even if it is not entirely dry. Carrying lighted cigarettes, pipes, or cigars around poultry houses should therefore be prohibited. Multistory poultry houses should be provided with tight-fitting doors at stairways to slow down the spread of flames and asphyxiating smoke in case of fire.

Gas heaters and brooders may be fire hazards if they are not carefully installed. LP gas tanks should be located outside the building away from windows. Carefully supported and protected copper tubing should be used for fuel lines except where a short, flexible connection is needed. For example, a

short, flexible connection at the hover is needed so the hover can be raised and lowered. Oil brooders also must be carefully installed to avoid oil leakage or flooding. All types of heating devices should be kept clean and in good operating condition to avoid fire hazards.

Infrared lamps and other high-temperature equipment used in brooder houses, farrowing houses, or lambing pens should be enclosed in guards which will prevent the heating units from touching the litter if they fall. This type of equipment should be mounted out of reach of animals and so placed that heat from the unit cannot ignite any combustible materials.

The Farm Shop

The farm shop is usually a part of the machinery storage building. It should not be located in or close to a building where hay, straw, oil, or other combustible material is stored. The shop should have a concrete floor and should be well ventilated to protect against the fire hazard caused by the use of flammable liquids and oily rags. The handling of gasoline in open containers should be avoided. Ventilation is particularly needed if spray painting is done in the shop. Benches for welding must not be of wood or combustible material. Self-closing metal cans should be provided for oily rags and the entire shop should be kept clean and free of trash. A dry chemical or a CO_2 (carbon dioxide) fire extinguisher suitable for use on flammable liquid fires should be kept handy.

Electrical and Heating Equipment for Service Buildings

Installation of electrical wiring should conform to the National Electrical Code. The wiring should be planned by a competent electrician or engineer and should be large enough to carry the expected load for all the equipment to be operated. All circuits must be protected by fuses or circuit breakers of the proper size. Use of oversize fuses or replacement of fuses with coins or metal strips may cause fires. Wiring systems should be electrically grounded. It is also important to have metal stanchions and drinking cups electrically grounded at both ends of the line of stanchions. Cows have been electrocuted as a result of short circuits in equipment or in wires having damaged insulation.

Electric lights in hay mows or other dusty places should be equipped with dusttight fixtures or placed inside glass jars. Bare lamps become hot enough to ignite dust or particles of hay which settle on them. Switches also should be dustproof. A lamp should never be suspended by the cord or wires which supply it with electricity.

Keep electric lamps clean.

Electric-, gas-, and oil-heating equipment should not be used unless the units are made by reliable firms and have been tested by and bear the label of the Underwriters' Laboratories or other well-recognized authorities. The installation should be in strict accordance with the manufacturer's directions and the National Fire Protection Association's national fire codes.

Coal- or wood-burning stoves in brooder houses, farrowing houses, milkhouses, potato and sweetpotato storages, and other utility buildings should have chimneys which conform to the requirements for dwellings (see p. 12). Clearances between stoves and woodwork should be as indicated in the section, Wood- and Coal-Burning Systems. Stoves in buildings with wood floors should be set on metal-covered shields or in shallow boxes of

sand large enough to catch hot ashes or embers falling out of the stove door. Straw, shavings, and other flammable litter must be kept well away from the stove. Ashes should be stored in metal cans, not in wood or pasteboard containers. Ashes should not be removed from the stove or heating plant while still hot; they should be given time to cool off after they are shaken through the grates.

Gasoline and Kerosene Storage

Gasoline, kerosene, and other flammable liquids are always potential sources of fire. Proper storage and careful handling will give reasonable protection against the ignition of fuels. The best storage for gasoline is in underground tanks, the next best is in substantial steel drums kept well away from all buildings. A pump should be used to draw gasoline from steel drums. Farmers' Bulletin 2156, Safe Use and Storage of Flammable Liquids and Gases on the Farm, gives more complete information on the use and storage of gasoline and kerosene. This bulletin may be obtained from the Office of Information, U.S. Department of Agriculture, Washington 25, D.C.

Crop Driers

Crop driers are fire hazards if they are improperly installed or operated. When existing storages are used for drying crops the drier should be connected to the crib or bin by a noncombustible duct at least 10 feet long. Temporary drying installations can be set up away from farm buildings so they will not be endangered by any fire hazard connected with the drying operation. Permanent, fire-resistant, complete drying units should be located at the distance from other buildings that is specified by insurance companies involved. It is recommended that air temperatures in crop driers not exceed 140° F. for drying crops on the farm.

Farmers planning to buy crop driers should check with their insurance companies to determine if their present insurance policies cover the operation of such equipment.

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